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# CURRENT LITERATURE

## BOOK REVIEWS

### Irritability of plants

The experimentation described in BOSE'S new volume[1] is marked by excellence of methods and execution. The presentation is in direct, clear, and in many places elegant English. The findings are rendered quickly available by comprehensive but concise summaries at the end of each chapter and at the end of the volume. One regrets that this excellent work is marred here and there by oldness of viewpoint and lack of knowledge of physiological literature.

In his older researches BOSE used the optical lever with the photographic method of recording. This made the taking of automatic records tedious, with the possibility of relatively few records during the active season of the plant. It also forced experimentation in an abnormal condition for the plant, namely, continual darkness. The resistance offered by the recording apparatus, both because of weight of the arm and because of the friction of the writing point on the black surface, was another difficulty in the taking of automatic records. The author has overcome all of these difficulties by his new and ingenious resonant and oscillating recorders. He has designed arms that are about 0.01 as heavy as those used with the muscle nerve, and the oscillating or resonant recorder gives a series of dots on the black surface rather than a continuous line. This reduces the friction to a very small fraction of that of the continuous record. In the *Desmodium* leaflet the author has shown that a continuous line gives a great reduction in the magnitude of the movement, while none occurs with the new recorder. His new apparatus also makes possible the recording of periods as short as 0.001 of a second. One is convinced that BOSE is reaching the optimum of accuracy and delicacy in the matter of automatic records of plant response, and this is much needed, for many fewer such records exist for plants than for animals.

This excellent experimentation results in a number of things of interest to plant physiologists; in some cases confirming views already held; in others showing prevailing views at error; and in still others giving exact determinations of physiological critical time periods. BOSE shows that the sum of stimulus law holds for a number of stimuli, as has been shown to be the case for geotropism, heliotropism, etc. In subtonic condition of an organ the stimulus itself renders the organ more excitable to the same stimulus. He has apparently established beyond doubt that conduction of a stimulus in the petiole of *Mimosa* cannot occur over a zone that is dead or in a state of rigor, contrary to the claims of HABERLANDT and PFEFFER. As BOSE puts it, conduction of stimuli in this organ is a true "excitatory" or "physiological" process. His statement that plant physiologists universally hold that conduction of stimuli in plants is "hydromechanical" shows that he has entirely overlooked the generally accepted and much quoted classic of FITTING (1907) on the conduction of the light stimulus in the coleoptile of *Avena*. The author's findings in *Mimosa* do not, contrary to his statement, disprove a universally held view in plant physiology, but they merely show that the conduction of stimuli in this form is consistent with that in *Avena*, which probably represents the general situation for plants. He has shown that PFLUGER'S laws of polar excitation in animal tissues hold for plant tissues, and supplements these by two more laws that hold for strong currents. This is only one of many illustrations that BOSE brings forward of fundamental likenesses in stimulus effects and response in plants and animals. Records are given of very accurate determinations of latent periods (the time elapsing between application of the stimulus to the pulvinus and the beginning of movement) in the leaves of *Mimosa* and other motile leaves, as well as exact measurements of the rate of conductivity of stimuli. In the primary pulvinus of *Mimosa* the shortest latent period found was 0.06 second, and the average 0.1 second. In subtonic but not in optimum condition of the organ, increased strength of the stimulus shortens, while in general fatigue prolongs, and a rise in temperature shortens this period. The maximum rate of conduction was that found in the petiole of *Mimosa;* it was 30 mm. per second. Conditions that shorten the latent period also increase the rate of conduction. In subtonic but not in optimum condition of the organ, previous application of the stimulus hastens the rate of conduction. Conduction takes place in both directions, but not always at the same rate. In *Biophytum*, for instance, the velocity is greater in the centrifugal than in the centripetal direction.

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[1] BOSE, J. C., Researches on irritability of plants. xxxiv+376. *figs. 190.* London: Longmans, Green & Co. 1913.

BOSE emphasizes that conduction of the stimulus proper is accompanied by a wave of contraction and of galvanometric negativity. This is contrasted with the wave of galvanometric positivity which passes over a stimulated non-living object or as a secondary effect of stimulation in the living organ, and which travels much faster than the primary stimulus effect. The author emphasizes this distinction between true "excitatory" or "physiological" conduction, accompanied by contraction and galvanometric negativity, and the "physical" conduction, marked by galvanometric positivity. This is good, but physiology is beyond the stage of stopping with such distinctions. It now recognizes that the effect and conduction of stimuli proper in the organism are physical also, undoubtedly more complex than the behavior in the non-living, but physical nevertheless. Two groups of facts, each in part and both together, probably fully explain the physics of the contractile wave with its galvanometric negativity. One group of workers[2] has produced much evidence that the living cells of the organism are surrounded by semipermeable membranes with a difference in electrical potential outside and inside the membrane, and that any stimulus causes an increase of permeability with its necessary contractile and electrical effects. Again, the behavior of colloids in the form of gels leads one to believe that hydration-changes accompany response to stimuli in the protoplasm, which always involve contractile and electrical effects. These are probably the physical factors entering into BOSE'S "physiological" response and conduction. With death (coagulation of the colloids) both the membranes and the colloids disappear, and with them the "physiological" response.

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[2] Science N.S. **37**:959–974. 1913.

Many statements in the book show a lack of familiarity with the anatomy and physiology of plants. The author speaks repeatedly of depleted energy in the pulvinus of *Desmodium*, or of its receiving energy from without. This is rather vague in the light of what we know of the energy relations of plants. He applies systole and diastole to the pulvinus as he does to the heart, and compares the petiole of *Mimosa* with the nerve and the pulvinus with the muscle of a nerve muscle preparation. Both of these statements are made in spite of the fundamental differences in structure and function. The death point for plant cells is fixed, as if mysteriously, at 60° C., and death from a lower temperature is spoken of as being very different in nature. BOSE fails to recognize that death at supramaximal temperatures is a matter of coagulation of certain proteins, and that at any supramaximal temperature the time of its application is a function in the process. At temperatures lower than 60° C. the time must be longer. The reason that 60° C., rather than a lower or higher temperature, is found to be the death temperature in a given species, is because of his method of heating, namely, 1° C. rise in temperature per minute. A slower heating would give a lower death point, and a faster one a higher one. The reason for the constancy of this temperature for the different species studied is not so clear. BOSE should have been acquainted with LEPESCHKIN'S[3] work on this subject. It is of some interest that the death temperature is lowered by fatigue to 37° C., and by copper sulphate to 42° C. This emphasizes again the marked lability of certain cell proteins, and reminds one of LEPESCHKIN'S results showing that they are coagulable even by pressure.

BOSE is adding much to the subject of plant response, but his excellent methods could add much more if they were applied in the light of our modern knowledge of the physics and chemistry of living cells and of plant response in general.—WILLIAM CROCKER.

### Biology and capillary analysis of enzymes

GRÜSS[4] has brought together in book form the results of his work on enzymes, which has extended over a period of several years. Some of his con-

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[3] Ber. Deutsch. Bot. Gesells. **30**:703–714. 1913.

[4] GRÜSS, J., Biologie und Kapillaranalyse der Enzyme. 8vo. pp. vi+227. *col. pls. 2. figs. 58.* Berlin: Gebrüder Borntraeger. 1912. *M.* 16.